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SCIENCE

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THE OUTLOOK FOR AGRICULTURAL RESEARCH

AT the close of the World War, the outlook for research in the United States, both as to its immediate future and as to its permanent place in our economic structure, was very rosy. The tremendous part which the results of new discoveries played in the conduct of the war and in the sustenance of the nations whose normal productive energies were being diverted to war purposes, had attracted popular attention to and support of research activities. Research men had received new impetus and enthusiasm from the practical benefits of their work which became suddenly manifest. Organization of research agencies and the general recognition of the possibilities of cooperative organized attack upon the problems which need scientific study seemed to promise much for the immediate future of research work.

All this seemed to be particularly true of research in agriculture. The vital importance of the products of agriculture to the national need had been emphasized again by the war-time needs and slogans. Nations, like ours, which had been going through a period of almost inconceivable industrial development had come to hold in light esteem the earlier understanding of the importance of a sound and permanent agricultural system, which knowledge had been forced upon the preceding generation of American statesmen by the post-Civil-War experiences. But the vital importance of a steady production of a sufficient supply of agricultural products for the world's needs had been so emphasized by the war, and America's strategic position as a food-producing nation had been so clearly shown, that it seemed that a re-awakening of public interest in the support of anything which would aid in insuring a sound national agricultural policy was inevitable.

Now, however, the expected *renaissance* in agricultural research seems to have been temporarily thwarted by the business depression and by the general clamor against increased expenditures of public funds for any purpose. I believe that this condition is only a temporary one. We are going through an experience which brings a blush of shame to the cheek of every loyal American. We are seeing every principle of patriotism and devotion to public welfare which were such powerful stimulants to individual and national effort during the war submerged by the petty political jealousies.

These are reconstruction days. War-time fever has only just left the body politic. Physical power, mental acumen, and spiritual force seem to be still at a low ebb. No true American patriot believes that these are manifestations of sound, normal American life. And every true American, embued with the characteristic hopeful American spirit, looks forward with optimistic confidence to a speedy recovery of sound body and sound mind in our national existence.

Hence, we ought not to be discouraged or dismayed by the present temporary reaction in popular enthusiasm for our research work. This lack of enthusiasm ought not to be mistaken by us to be any definite or permanent opposition to agricultural research. The lessons of the war-time emergency concerning the importance of agriculture to the national life are too clear and too convincing to be easily forgotten. Indeed, it is the plain duty of those of us who, by our engagement in public service for agricultural development, have a unique opportunity to shape public opinion and to mold public sentiment, to see to it that this important lesson is not forgotten and that the proper place of agricultural research in relation to sound agricultural development continues to be kept clearly in mind.

The fundamental place of agricultural research in any system of agricultural education and development is so apparent that it needs no elaborate discussion or argument concerning it. It is an old and trite saying that "no stream can rise higher than its source." And it is a self-evident fact that the source of agricultural knowledge is careful scientific investigation of the laws of nature.

This was clearly recognized by the earlier leaders in agriculture who, soon after the establishment of the Land-Grant Colleges began the investigational work which soon led the way to the establishment of the agricultural experiment stations as definitely organized agencies for agricultural research work. In most of the States these stations were organized as a unit of the college and under the administrative supervision of the same officers who administered the teaching functions of the institutions. In a few states there were organized experiment stations which were entirely separated in their administration, functions, and activities from the teaching service. But in most cases the research work was closely associated with the teaching duties of the faculty of the agricultural college, and in about one-half of the states the college itself is an integral part of the state university with its graduate school, which also has general research possibilities.

The need for post-graduate training for teaching, research, and extension workers in agriculture has resulted in the development of graduate schools in many of the separately organized land-grant colleges. Thus it has come about that in most of the states there are two agencies or units of the land-grant colleges, which are to be considered as potential sources for agricultural research work; namely, the experiment station and the graduate school.

In any consideration of the future possibilities for agricultural research, therefore, we ought to count upon the development of these two types of agencies. The growth of these two, side by side, in the same institutions has often led to a confusion of their functions and possibilities, which may be wholly unconscious and unintentional in the minds of the members of the staff and administrative officers of these combined institutions; but which is quite apparent to those of us who are connected with the separate research institutions. It is, perhaps, because of my recent change from one type of these institutions to the other that the inevitable distinctions between graduate school research work in agriculture and agricultural experiment station research work have forced themselves upon me. They now appear to me to be so significant as to justify my commenting upon them in the hope of at least partially clarifying the situation and so affording a better basis for future development of all of the possibilities of agricultural research work.

The questions at issue may be more clearly indicated if formulated into two definite queries, the reply to the first of which is necessarily dependent upon the answer to the second. These questions are: "Is the maintenance of an experiment station as a separate unit of the land-grant college desirable?" and "How does an experiment station differ in its methods and accomplishments from other agencies for research, such as the graduate school, or the personal research work of an academic faculty?"

Turning first to the second of these questions, namely, "How does an experiment station differ from other agencies for research?" my answer is that it differs in the environment or atmosphere which it creates. Its atmosphere is that of research for the accomplishment of definite economic progress; while that of the graduate school is chiefly research for training of graduate students in the method of critical investigation, and that of individual research work is the promotion of individual professional standing and welfare. Now, I recognize many exceptions which might be taken to such a generalization when applied to the cases of brilliant individual research workers in these different organizations. But I am discussing now the environmental conditions of the organized entities or institutions known respectively as experiment stations, graduate schools, or university faculties.

As between the research work done at an experiment station and that done at a graduate school, both parts of the same land-grant college for example, the physical materials worked with may be the same and the final results of the investigation of any given problem by either agency ought to be the same, provided the ultimate truth of the matter is reached; but the environment under which the investigators will work is essentially different. In both organizations there may be less mature and less experienced investigators working under the inspiration and guidance of older and more experienced research men; but in the graduate school the immediate object to be attained is the completion of the work in such a way that it can be formulated into and defended before a group of examiners as a thesis; while in the station, the investigation is to eventuate in some contribution to agricultural science or practise which must stand the test of practical application in farm management operations. It is possible that the methods and mental attitude of the leader of the work toward its ultimate outcome may be identical in each case; but that of his assistants will most certainly be different, and the leader himself is almost super-human if he is not influenced by the desire to see his students present "a good thesis" as the result of the work. But the more essential differences lie in the undivided interest in and devotion to research problems which is, or at least ought to be, characteristic of the experiment station. Faculty men necessarily have to be interested in class-room problems and in the preparation of the results of their research in forms which are pedagogically sound and academically attractive. Graduate students are usually taking course work in addition to thesis work and are likely to have their interest in their investigations diverted from the main issue, or their observations influenced by their coordination or contrast with class-room ideas. I am not arguing against research work in the graduate schools. On the contrary, I regard it as the very essence, the *sine qua non*, of graduate school work. Neither would I belittle the economic value of the results of the research work which is so well done in the graduate school.

What I am trying to point out is that there is a definite atmosphere or environment favorable to agricultural research which is provided by the experiment station organization which can not be provided by any other research agency. This being my answer to the second question propounded above, the answer to the first, namely, "Is the maintenance of a separately organized research agency known as an experiment station desirable?" must be an unqualifiedly affirmative one. I am not now discussing the question of the geographical or administrative separation of the station from the college. That is an entirely different question to be answered from entirely different considerations than those which are proper to this paper. But what I do urge is that the agricultural research work of the land-grant college, for which federal and state appropriations are given in order that the practise of agriculture may be improved and the economic welfare of the people enhanced, shall be so definitely organized into a distinct entity (having for its sole purpose the promotion of research) that the environment most favorable to successful research work may be created. I do not need to enlarge upon the details of staff conferences; of cooperative work upon the project by the proper men, regardless of administrative departments of instruction; of freedom from interruption of thought and of work by other duties; etc., which contribute to this environment favorable to a high type of agricultural research. These are familiar to you all. I do wish, however, to urge upon the director of the station, in each case, the importance of the maintenance of a definite station staff with definite assignments to it and of definite staff activities as a highly important factor in developing the atmosphere or environment which I have been attempting to describe and which I believe to be an important factor in the future success of agricultural research work.

There is an additional problem in the administration of experiment station work upon the solution of which I believe its future possibilities depend in considerable measure. I refer to the effect which may be produced upon both the character and the method of our research by the present demand for so-called "practical results" from it. An inevitable and altogether wholesome reaction from the extravagance of war-time expenditure has set in. I hope that it may continue, and that no object which does not promise definite improvement in our living conditions may successfully appeal for public financial support. I agree, therefore, that our expenditure of public funds for agricultural research must have as its proper justification the accomplishment of some definite "practical result." I believe, however, that a definite contribution to science which may make our structure of agricultural knowledge more complete, more sound, or even more beautiful, is a "practical" result of research work.

I have no patience with the dilatory browsing around in the field of the unknown in hopes that something interesting to the individual browser may turn up, which is sometimes lauded as "the search for truth for truth's sake," as a guiding principle in station research. I believe that each station project should be a definitely formulated effort to solve some problem which will contribute either to our knowledge of agricultural science or to our methods of agricultural practise. It is, of course, the second of these two types of contributions which is usually meant by the phrase "practical results," and contributions to agricultural scientific knowledge are regarded by some of our constituents as of doubtful desirability. I do not intend, however, to debate this particular point at length in this paper. I have indicated my own very definite convictions concerning it.

What I do wish to discuss, however, is the possible effect upon the methods of our research work of this continual pressure upon the station administration for so-called "practical results." This pressure may be either direct, in the form of active criticism of the station's program of work by individual or organized farmers, or it may be the indirect and insiduous influence of the ability to cite definite financial benefits to the state or nation from the result of each completed project of station work, as a matter of pride in achievement or as an influence in securing future moral and financial support for the station's program.

Whatever the character of the pressure may be, it will be most unfortunate for the ultimate success of agricultural research in America if this pressure is allowed to influence the methods by which the station research is conducted. I believe it to be a cardinal principle of station research that the investigations shall be pursued according to the very best possible methods of scientific inquiry by a staff of investigators who are as well trained in these methods as it is possible to obtain. It is, of course, fortunate for the man himself if he has had such practical experience in farm operations as will lead him to see the possible applications and ramifications of his problem and such a back-ground of experience is an undoubted aid in the selection and formulation of a project to be undertaken; but, on the other hand, it may be a real handicap if it so prejudices him against certain methods of study as to limit his working tools of investigation, or if it gives him such pronounced preconceptions as to the probable outcome of the investigation as to unconsciously warp his observations or conclusions. From the standpoint of the successful prosecution of station research an open and unbiased mind and the ability to use skillfully all the working tools which are afforded by a proper knowledge of fundamental sciences, are, in my judgment, better qualifications for station research than is any amount of practical farm experience.

I am not discussing preparation for extension or teaching of agriculture; but preparation for agricultural research. I do not wish to appear to belittle the value of practical farm experience to any worker in scientific agriculture. I know what its value has been to me. Nor do I underestimate its value in contributing to the solution of many problems which come to the station to be answered. But there are hundreds, if not thousands, of farmers in every state who have a vastly better wealth of farm experience to bring to the solution of these problems than we could possibly get for our station men. They can, should, and do contribute the part to the improvement of agricultural practises which farm experience can teach. They can not contribute what scientific inquiry has to add to agricultural knowledge and it is this latter contribution which our stations should be organized to provide.

I have every confidence that the future has even greater opportunities and successes in store for the contributions of science to agriculture than the past has had, and I, therefore, close this paper with the utterance of my profound conviction that the present apparent slight reverse is but a temporary phase of the general problem of agricultural development in America, and that the outlook is for future opportunities which will challenge and stimulate our very best efforts to meet them.

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ZOOLOGICAL RESEARCH AS A CAREER

IN the present state of the subject a person looking forward to a career in zoology must, in most cases, expect to find it in academic life. Here there are increasing opportunities leading out into special lines such as anatomy, physiology, genetics, histology, embryology, cytology, entomology, paleontology and in occasional cases into systematic work upon limited groups, such as fishes, reptiles, birds, mammals, molluscs, etc. The increased entrance requirements of professional schools, demanding scientific training, has led to larger numbers of students in the elementary zoological courses, thus making more teaching positions in colleges; while improved methods of instruction in anatomy, physiology, histology, and embryology have